



Predicting impacts of increased CO₂ and climate change on the water cycle and water quality in the semiarid James River Basin of the Midwestern USA

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Abstract:

Emissions of greenhouse gases and aerosols from human activities continue to alter the climate and likely will have significant impacts on the terrestrial hydrological cycle and water quality, especially in arid and semiarid regions. We applied an improved Soil and Water Assessment Tool (SWAT) to evaluate impacts of increased atmospheric CO₂ concentration and potential climate change on the water cycle and nitrogen loads in the semiarid James River Basin (JRB) in the Midwestern United States. We assessed responses of water yield, soil water content, groundwater recharge, and nitrate nitrogen (NO₃-N) load under hypothetical climate-sensitivity scenarios in terms of CO₂, precipitation, and air temperature. We extended our predictions of the dynamics of these hydrological variables into the mid-21st century with downscaled climate projections integrated across output from six General Circulation Models. Our simulation results compared against the baseline period 1980 to 2009 suggest the JRB hydrological system is highly responsive to rising levels of CO₂ concentration and potential climate change. Under our scenarios, substantial decrease in precipitation and increase in air temperature by the mid-21st century could result in significant reduction in water yield, soil water content, and groundwater recharge. Our model also estimated decreased NO₃-N load to streams, which could be beneficial, but a concomitant increase in NO₃-N concentration due to a decrease in streamflow likely would degrade stream water and threaten aquatic ecosystems. These results highlight possible risks of drought, water supply shortage, and water quality degradation in this basin.

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Resource Description

Climate Scenario :

specification of climate scenario (set of assumptions about future states related to climate)

Special Report on Emissions Scenarios (SRES), Other Climate Scenario

Special Report on Emissions Scenarios (SRES) Scenario: SRES A1, SRES A2, SRES B1

Other Climate Scenario: A1B

Exposure :

weather or climate related pathway by which climate change affects health

Food/Water Quality, Food/Water Security

Food/Water Quality: Chemical

Geographic Feature: ☒

resource focuses on specific type of geography

Other Geographical Feature

Other Geographical Feature : Basin

Geographic Location: ☒

resource focuses on specific location

United States

Health Co-Benefit/Co-Harm (Adaption/Mitigation): ☒

specification of beneficial or harmful impacts to health resulting from efforts to reduce or cope with greenhouse gases

A focus of content

Health Impact: ☒

specification of health effect or disease related to climate change exposure

Health Outcome Unspecified

Mitigation/Adaptation: ☒

mitigation or adaptation strategy is a focus of resource

Mitigation

Model/Methodology: ☒

type of model used or methodology development is a focus of resource

Outcome Change Prediction

Resource Type: ☒

format or standard characteristic of resource

Research Article

Timescale: ☒

time period studied

Long-Term (>50 years)

Vulnerability/Impact Assessment: ☒

resource focus on process of identifying, quantifying, and prioritizing vulnerabilities in a system

A focus of content